

SNOW AND RAILWAY TRANSPORTATION.

By ANDREW H. PALMER, Meteorologist.

(Dated: Weather Bureau, San Francisco, Calif., July 22, 1919.)

Throughout the northern part of the United States, snow is a costly impediment to transportation during several months of every winter. In great cities like New York, Chicago, and Boston, the cost of snow removal from the streets amounts to hundreds of thousands of dollars per annum. Records of the New York City street cleaning department show that in the winter of 1916-17 the cost of removing snow and ice from the streets of New York City was \$1,127,018, while in the winter of 1917-18 it was \$2,676,603. In all northern cities street railways find this inevitable item of expense is of large proportions. When the Weather Bureau makes a forecast of snow in Boston, the Boston Elevated Railroad, which operates most of the street cars in that city, holds several hundred reserve men in readiness for immediate duty, both during the day and at night. In the case of steam railroads the snow problem is one of prime importance, and it has received the attention of leading engineers.

The amount of snowfall varies greatly in different parts of the United States, and the conditions under which it falls also vary. For this reason different railroads attack the problem differently. In many parts of the eastern United States most of the railroads each autumn put up wooden fences, 4 to 6 feet in height. These are built in sections. The fence consists of wooden boards nailed 3 or 4 inches apart to heavy wooden posts. The fence is necessary usually only on the west or north side of the track, as drifting snow is carried mostly by northerly or westerly winds. By breaking the force of the wind near the ground it causes the snow to be precipitated in a drift on the leeward side of the fence, leaving the track beyond relatively clear. This costly construction is necessary for many miles on the open prairies.

Some railroads of the plains States have recently planted rows of trees for windbreaks. Those species of trees were selected which are of hardy constitution and which grow rapidly. The experiment proved so successful that during the summers of 1917 and 1918 many miles of young trees were planted in this manner. They were placed close together, and a few years hence they will form a barrier which will break the force of the driving snow-bearing winds and cause the snow to be deposited at the bases of the trees, leaving the track clear.

During the summer of 1916 the Union Pacific Railroad made various shortenings of its transcontinental routes in Colorado and Wyoming. In doing so several new gulches and canyons were created along the right of way. The following winter, that of 1916-17, proved to be one of abundant snowfall in the Rockies, and the driving winds soon filled these gulches after each snowstorm. Tie-ups resulted, each lasting several days. Transcontinental trains were delayed, and San Francisco and Los Angeles received no eastern mail for three to five days on each occasion. Steamers about to sail for the Orient delayed their departures in order to await the arrival of passengers and mail en route from the East. During the following summer windbreaks consisting of young trees were placed at appropriate places above the canyons, and eventually, it is hoped, trouble due to snow blockades will largely be eliminated.

The railroads which cross the Cascade Mountains of Washington and Oregon and the Sierra Nevada of California have to contend with a snow problem of great difficulty. In these mountains, where the snowfall is the

heaviest in the United States, snow accumulates on level ground to a depth of 25 to 30 feet, and depths twice as great may be found in canyons and gulches.¹ In the high Sierra Nevada of California accurate records kept by co-operative observers of the Weather Bureau show that at certain places a snowfall of 60 to 65 feet in one winter is not uncommon. The greatest snowfall in the United States is that at Tamarack, Alpine County, Calif., altitude 8,000 feet, where 884 inches, or 73.7 feet, of snow fell during the winter of 1906-7.²

When snow on level ground accumulates to depths of a few feet, it is the custom of the railroads to remove the snow from the track by means of a locomotive push plow, as is shown in fig. 1, or by means of a rotary plow, as shown in fig. 2. It is not unusual for a locomotive to come into the roundhouse with the appearance of the one shown in fig. 3. The cleared tracks through a typical western railroad town are shown in figs. 4 and 5. In all exposed tracks the source of most troubles caused by snow is that of the blocking and the freezing of switches, signal apparatus, and turntables. To keep these open requires considerable hand labor. (See figs. 6 and 7.)

When snow on level ground accumulates to a depth of 25 to 30 feet, and perhaps twice that depth in canyons and gulches, it is apparent that its removal is impossible. The problem was solved by the engineers in charge of the construction of the Central Pacific Railroad, now the Overland Route of the Southern Pacific. In crossing the Sierra Nevada, this railroad climbs from 71 feet at Sacramento, Calif., to 7,017 feet at Summit, Calif., and descends to 4,532 feet at Reno, Nev. In order to operate during the winter months it was found necessary to construct 32 miles of snowsheds between Blue Canyon and Truckee, at a cost of \$42,000 a mile over single track and \$65,000 a mile over double track. (See figs. 8, 9, 10, and 11.) On an average, \$150,000 a year is spent for upkeep and renewals, the expenditure for a typical year, 1914, having been \$65,000 for repairs and \$91,000 for renewals. The average life of a shed is 22 years. The sheds are built of massive timbers and are designed to sustain snow 16 feet in depth. When the snow gets deeper than 16 feet it must be shoveled off by hand. At certain points where the railway is located along steep slopes, thousands of tons of snow slide over the tops of the sheds each winter. At these places a kind of apron, technically known as a "backoff," 30 to 40 feet in length, is built on the upslope side of the shed in order that the snow may slide harmlessly over the top. Even though timbers 12 inches by 14 inches in cross section were used in its construction, 48 feet of snowshed near Blue Canyon collapsed because of the weight of snow, on February 15, 1915. The fire hazard in these sheds, naturally, is great. For fire-fighting apparatus four trains in summer and two trains in winter are kept under constant steam. All local engines carry pumps, and are followed by tank cars filled with water for fire-fighting purposes. The locomotives used on this mountain division are of massive construction, and are the most powerful in California. (See fig. 12.) Concrete snowsheds have been built on other railroads to offset the

¹ Palmer, Andrew H., "The Region of Greatest Snowfall in the United States." MONTHLY WEATHER REVIEW, vol. 43, May, 1915, pp. 217-221.

² Compare, however, Fisher, Lawrence C., "Snowfall on Mount Ranier, Washington." MONTHLY WEATHER REVIEW, vol. 46, July, 1918, pp. 327-330. At Paradise Inn in the winter of 1916-17, the only winter snowfall which was observed there, the total exceeded 789.5 inches.



FIG. 1.—A locomotive push plow at work in the region of greatest snowfall. (Photograph by Fred Rath.)



FIG. 3.—A Southern Pacific locomotive at the end of a winter run.



FIG. 5.—Cleared tracks on the Southern Pacific near Emigrant Gap, Calif. (Photograph by Fred Rath.)



FIG. 7.—Railroad snowsheds in the high Sierra Nevada Mountains of California.

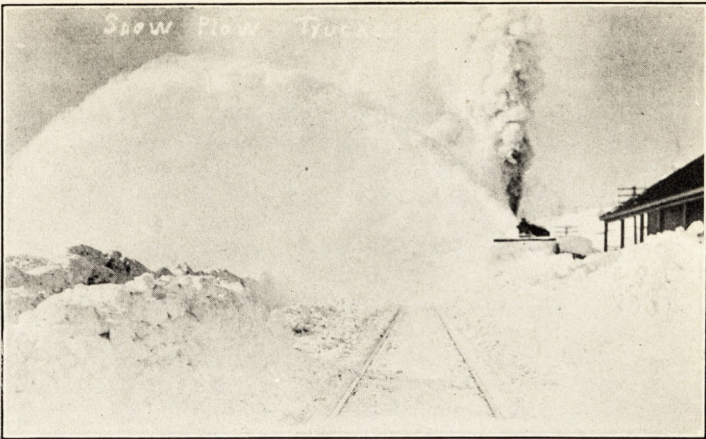


FIG. 2.—A rotary snowplow at work on the Southern Pacific at Truckee, Calif.



FIG. 4.—Cleared tracks on the Southern Pacific at Blue Canyon, Calif. (Photograph by W. E. Banbrook.)

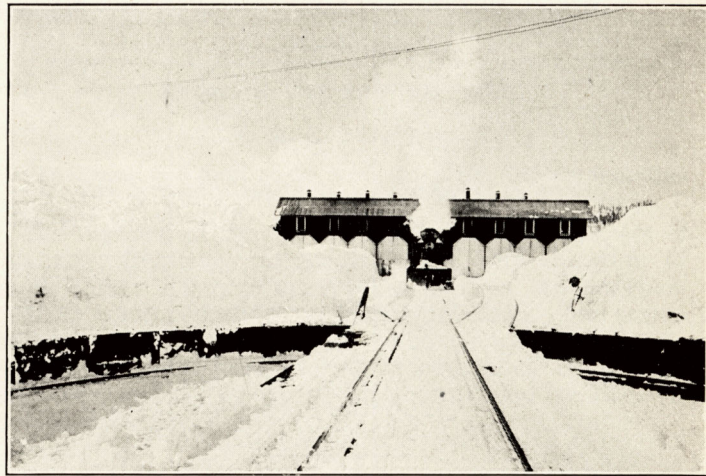


FIG. 6.—Snow makes the maintenance of a turntable a costly matter in the winter. (Photograph by Fred Rath.)

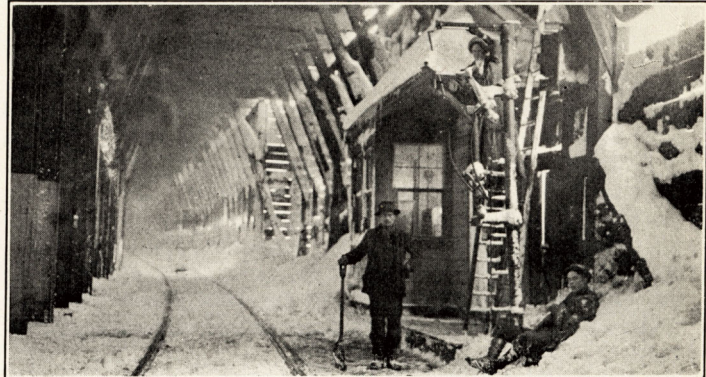


FIG. 8.—The inside of a railroad snowshed at Crystal Lake, Calif.

fire hazard, but their initial cost renders that form of construction almost prohibitive.

Besides actually impeding traffic, snow is sometimes a costly factor in operation in that it occasionally causes destructive slides. These slides not only sweep away the snowsheds but sometimes occur during the passage of a train, with resultant disaster. On January 22, 1916, a snowslide struck an all-steel passenger train near Corea, Washington, cutting it in two, and sweeping several coaches into a ravine 120 feet below, with resultant loss of several lives. In order to combat the hazard of snowslides the U. S. Weather Bureau has studied the conditions under which they occur. During the season when there is danger from such slides, warnings are issued to proceed cautiously, and in some instances train dispatchers have stopped the movement of trains until the danger has passed.

While the recurring snows of winter are a great benefit to agriculture, both as a source of moisture and as a protective blanket to submerged vegetation, they are a costly impediment to railway transportation. In severe winters, like that of 1917-18, the delay to transportation caused by excessive snowfall sometimes affects business in general. Occasionally it causes real peril, through the delay resulting in the delivery of food and fuel. Automobile trucks are already an important factor in the transportation of freight and express matter between adjacent cities and towns. These too are impeded by deep snow

to such an extent that service must occasionally be abandoned for brief intervals during the winter half-year.

In an article entitled, "Millions Saved on Mild Winter,"³ published in the New York Times, April 6, 1919 (sec. 2, p. 2), it is stated that in an average winter the cost to the railroads of the United States for removing snow and ice from the tracks is between \$5,000,000 and \$6,000,000. In a severe winter it may cost much more. For example, in the remarkable winter of 1917-18 the cost was between \$7,000,000 and \$8,000,000. In a mild winter the cost may be much below the average. An eastern railroad official estimated that in a mild winter the cost may be 25 per cent below the average figures given above, while in an extremely mild winter, like that of 1918-19, there may be a saving of fully 50 per cent of the figures given.

While a heavy snowfall adds greatly to the cost of maintenance of way, it also causes loss through interrupting the flow of freight, and eventually to business and industry in general. Furthermore, when coal arrives at its destination solidly frozen in cars which have to be thawed out, further delay and increased costs are unavoidable. For these reasons the general character of a winter is often reflected by the cost of operation figures appearing in the reports of the railroads of the northern portion of the United States.

³ Abstract of this article appears in MONTHLY WEATHER REVIEW, vol. 47, March, 1919, p. 170-171.

SNOWFALL AND SNOW COVER ON THE ST. BERNARD ROAD (ENTREMONT VALLEY) IN WALLIS, FROM 1904 TO 1913.

By P. L. MERCANTON.

(Abstracted from *Meteorologische Zeitschrift*, Nov.-Dec., 1918, pp. 260-272.)

By means of measures made during the winters from 1904 to 1913, by postal-service men and others passing along the road, it has been possible to obtain mean values of the snowfall and snow cover during the winter months. These measures were made at the first and the middle of the months, by noting the snow depth on graduated telegraph poles along the road. The following table is presented:

STATION OF ORSIERES (alt. 970 meters).

	Nov. 1.	Dec. 1.	Jan. 1.	Feb. 1.	Mar. 1.	Apr. 1.	May 1.	June 1.
Snowfall during previous month...	cm. 3	cm. 11	cm. 23	cm. 25	cm. 25	cm. 12	cm. 1	cm. 3
Snowfall since beginning of winter.	3	11	37	62	87	99	100	103
Snow cover, total.	.....	10	13	14	18	1	0	0
Snow cover, monthly increase.	.....	.....	+3	+1	+4	-17	-1	.....

STATION OF ST. PIERRE (alt. 1,630 meters).

Snowfall during previous month...	25	34	53	43	50	62	20	22
Snowfall since beginning of winter.	26	60	113	156	206	268	288	310
Snow cover, total.	.....	28	27	81	52	28	0	0
Snow cover, monthly increase.	.....	.....	+4	+4	+21	-24	-28	.....

STATION OF GREAT ST. BERNARD (alt. 2,230 meters).

Snowfall during previous month...	88	155	191	119	120	158	98	72
Snowfall since beginning of winter.	115	270	461	580	700	858	956	1,028
Snow cover, total.	29	46	66	100	168	197	169	75
Snow cover, monthly increase.	.....	+17	+20	+34	+66	+31	-37	-85

These figures show the maximum fall to be during December and January; the greatest depth of snow cover to be during March and April; the greatest increase of depth of snow cover during February. After the maximum depth is attained, however, it decreases rapidly during May and June. Naturally, the higher stations

show greater intensities of snow, in respect to depth and amount.—C. L. M.

SNOW IN THE FRENCH ALPS.

By M. E. BENEVENT.

Abstract reprinted from *Geogr. Review*, April, 1919, p. 273. Article in *Recueil des Trav. de l'Inst. de Geogr. Alpine*, vol. 5, 1917, No. 4, pp. 403-497.]

The regimen of the snowfall is discussed in respect of quantity, frequency of precipitation, and duration of snow cover. In conclusion these factors are analyzed in their combined effect on human relation. The region naturally falls into two main subdivisions—the Northern Alps, whose precipitation is controlled by oceanic influence, and the Southern Alps, controlled by Mediterranean influence.

SNOW CONDITIONS AT GENEVA IN THE 60 YEARS 1857 TO 1917.

By RAOUL GAUTIER.

[From abstract by J. V. Hann, *Meteorologische Zeitschrift*, Jan.-Feb., 1918, pp. 44-46.]

This investigation concerns itself with the average depth of snow, the number of days of snow, and the length of time the snow remained on the ground. Of the mean for 60 years, we have for the average depth of snow, 42.4 cm.; for the average number of days of snowfall per year, 8.2; for the length of time of snow on the ground, 17.2 days. The maxima for these values, however, are 172 cm., 30 days, and 86 days, respectively. The exceptional years and unusual instances of snowfall are discussed in the latter part of the article.—C. L. M.